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ECONOMY OF TIME IN ARITHMETIC

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In September of 1913 a questionnaire was sent by Dr. Coffman, of the University of Illinois, and myself to the city superintendents listed in the directory of the United States Bureau of Education, which includes practically all of the cities with a population of 4,000 and over—about 1,700 in all. The same questionnaire was sent to every sixth county superintendent in the United States.

The questions were answered by 52 per cent of the city superintendents, and by 24 per cent of the county superintendents. Returns were received from practically every sized city in the country. However, the larger cities were a little better represented in the matter of replies than were the smaller cities and rural districts. Each section of the country was well represented in returns. Thus it can be said that the data here submitted represent the attitude of one-half of the superintendents distributed quite evenly over the country as to size of city and geographical location.

QUESTIONNAIRE

ECONOMY OF TIME AS RELATED TO MATERIAL USED IN ARITHMETIC

City......................State......................

Underscore once the subjects which should receive slight attention; underscore twice the subjects which should be eliminated: apothecaries' weight, troy weight, furlong, rood in square measure, dram, quarter in avoirdupois weight, surveyors' tables, foreign money, folding paper, reduction of more than two steps, long measure of G.C.D., L.C.M., true discount, cube root, partnership, compound proportion, compound and complex fractions, cases in percentage, annual interest, longitude and time, unreal fractions, alligation, metric system, progression, aliquot parts.

Others..

Underscore the subjects which should receive more attention than is usually given: addition, subtraction, multiplication, division, fractions, percentage, interest, saving and loaning money, banking, borrowing, building and loan associations, investments, bonds and stocks, taxes, levies, public expenditures, insurance as protection and investment, profits in business, public utilities.

ECONOMY OF TIME AS RELATED TO THE METHOD USED IN TEACHING

Percentage of recitation time in arithmetic which should be given over to *strictly drill* exercises in each grade.

Grade	1	2	3	4	5	6	7	8	9
Percentage	___	___	___	___	___	___	___	___	___

Percentage of recitation time in arithmetic which should be given over to *rationalization* work in each grade.

Grade	1	2	3	4	5	6	7	8	9
Percentage	___	___	___	___	___	___	___	___	___

Approximate number of minutes *per week* given over to recitations in arithmetic in *your* schools in each grade.

Grade	1	2	3	4	5	6	7	8	9
No. Minutes	___	___	___	___	___	___	___	___	___

Remarks:..

....

....

....

....

Signed.................City...................

MANIPULATION OF DATA[1]

The returns were distributed so as to reveal differences, if any, between the responses of school men in the different sections of the country and for the cities of different sizes. Some of the superintendents answered only a part of the questions; hence the totals in the various parts of the report are not all the same. All doubtful answers were eliminated or checked by means of a supplementary inquiry asking for verification of statement.

MATERIAL USED IN ARITHMETIC

The percentage of superintendents who favored elimination was calculated so as to show the difference in attitude toward each of the twenty-five topics suggested. A large percentage favored the elimination of certain formal subjects such as alligation, cube root, unreal fractions, progression, etc., and certain more or less obsolete tables such as paper-folding, surveyors' measure, etc. Table I shows the exact distribution for each subject.

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[1] This report would have been impossible had it not been for the painstaking statistical work done by a group of students in the graduate seminar in the College of Education, State University of Iowa. The following men assumed the chief responsibility: James Richardson, Chester Buckner, H. W. Anderson.

TABLE I

PERCENTAGE OF SUPERINTENDENTS WHO FAVOR ELIMINATION OF THE TOPICS, DISTRIBUTED SO AS TO REVEAL DIFFERENCES IN ATTITUDE IN LARGE CITIES, CITIES AND COUNTIES, AND FOR ALL CITIES

Topic	Cities of 100,000 and Over	Cities and Counties	All Cities
	Per Cent	Per Cent	Per Cent
Apothecaries' weight	72	51	53
Troy weight	75	40	42
Furlong	85	70	72
Rood in square measure	13	19	20
Dram	78	58	60
Quarter in avoirdupois	81	66	68
Surveyors' tables	72	43	47
Foreign money	25	27	28
Folding paper	63	34	35
Reduction of more than two steps	25	21	22
Long measure of G.C.D.	66	33	35
Least common multiple	25	20	22
True discount	66	44	47
Cube root	56	41	46
Partnership	50	23	25
Compound proportion	72	49	52
Compound and complex fractions	28	24	26
Cases in percentage	28	18	20
Annual interest	63	40	41
Longitude and time	13	7	8
Unreal fractions	72	70	74
Alligation	88	82	85
Metric system	41	19	20
Progression	88	63	67
Aliquot parts	9	19	21

Many superintendents who did not go so far as to favor absolute elimination did favor the plan of giving less attention to these subjects. Table II shows the percentage of superintendents distributed for each subject.

Chart I is made up by combining Tables I and II and reveals the attitude of 867 superintendents toward these topics. The cross-hatched portion indicates the percentage of superintendents who favor the elimination of each of these subjects; the shaded portion indicates the percentage of superintendents who favor giving less attention to each of these subjects; and the unshaded portion indicates the percentage of superintendents who are satisfied with the present status. It is seen from Chart I that the superintendents are overwhelmingly inclined to favor the elimination or at least a lessening of emphasis on these subjects.

TABLE II

PERCENTAGE OF SUPERINTENDENTS WHO FAVOR THE PLAN OF GIVING LESS ATTENTION TO THE TOPICS, DISTRIBUTED SO AS TO REVEAL DIFFERENCES IN ATTITUDE IN LARGE CITIES, CITIES AND COUNTIES, AND FOR ALL CITIES

Topic	Cities of 100,000 and Over	Cities and Counties	All Cities
Apothecaries' weight	31	37	36
Troy weight	32	46	44
Furlong	12	20	19
Rood in square measure	37	39	42
Dram	18	24	23
Quarter in avoirdupois	14	17	17
Surveyors' tables	40	40	40
Foreign money	47	57	57
Folding paper	31	34	35
Reduction of more than two steps	45	46	48
Long measure of G.C.D	47	39	40
Least common multiple	50	44	45
True discount	27	31	31
Cube root	34	39	37
Partnership	39	43	44
Compound proportion	38	33	32
Compound and complex fractions	49	42	44
Cases in percentage	36	34	35
Annual interest	35	32	31
Longitude and time	55	55	56
Unreal fractions	9	17	15
Alligation	4	10	9
Metric system	42	42	44
Progression	12	21	20
Aliquot parts	28	31	32

Analyses of these data indicate that the superintendents of the larger cities are inclined to favor more elimination than are the superintendents of the smaller cities. The returns from the county superintendents who represent the rural schools seem to reveal no striking differences in attitude.

Analyses of the replies on the basis of the geographical sections of the country indicate that there is a slight difference between the North and the South, but this is no greater than the difference to be found between the North Central division and the North Atlantic division.

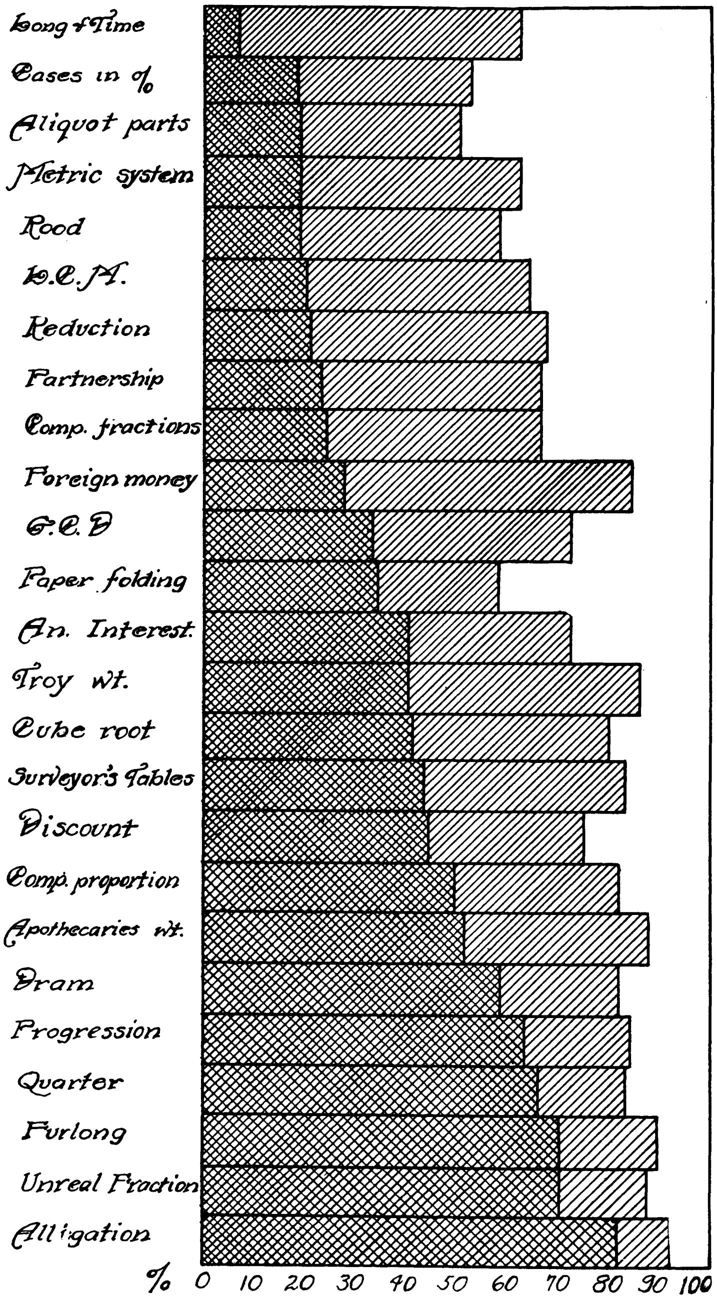

CHART I.—Percentage of superintendents who favor "elimination" or "less attention" (830 cities represented).

After distributing and tabulating the material in order to learn of differences in cities of different sizes in different sections of the country, it seems safe to say that the differences are so slight that Chart I can be taken as a representative measure of the attitude of the superintendents of the country toward the elimination or decrease of attention in regard to the different topics in the list.

ADDITIONAL EMPHASIS

The percentage of the superintendents who favored the plan of increasing the emphasis upon certain subjects was tabulated so as to show the different attitudes toward each of the subjects suggested. A large percentage were in favor of giving more emphasis to the fundamental subjects such as addition, subtraction, multiplication, and division. There was also a very strong sentiment in favor of increasing the emphasis on the applications of arithmetic to the social and economic conditions of the day; such as the saving and loaning of money, taxation, public expenditure, insurance, etc. Table III shows the exact distribution for each subject.

TABLE III

PERCENTAGE OF SUPERINTENDENTS WHO FAVOR THE PLAN OF GIVING MORE ATTENTION TO THE TOPICS LISTED, SO AS TO REVEAL DIFFERENCES IN ATTITUDE IN LARGE CITIES, CITIES AND COUNTIES, AND FOR ALL CITIES

Topic	Cities of 100,000 and Over	Cities and Counties	All Cities
Addition	59	75	75
Subtraction	50	68	69
Multiplication	59	72	72
Division	56	69	70
Fractions	56	66	65
Percentage	31	51	50
Interest	25	41	39
Saving and loaning money	50	61	61
Banking	38	40	39
Borrowing	22	37	37
Building and loan associations	13	46	48
Investments	16	44	44
Bonds and stocks	9	20	20
Taxes	25	53	53
Levies	6	36	35
Public expenditure	28	54	55
Insurance	31	54	55
Profits	28	47	46
Public utilities	34	57	57

The replies were also tabulated on the basis of size of the different cities represented. The superintendents of the larger cities seemed to be less inclined to favor an increase in attention to these subjects. This may be due to the fact that these cities are already giving more emphasis to these subjects than are the small cities.

The replies were tabulated on the basis of the geographical sections of the country. Only a slight difference was found in this particular. The South is perhaps slightly better satisfied with present conditions. This may be due to a situation similar to that in the large city. Chart II, based on the returns from all cities, seems safely to represent the present attitude toward the increased emphasis upon these topics. The shaded portion indicates the percentage of superintendents who favor giving more attention to each of these subjects.

POSSIBLE ECONOMY OF TIME

In connection with the special problem in which the committee is interested—namely, to find out if conditions are favorable for effecting an economy of time by means of the elimination of certain subjects, or by means of reducing the time being given these subjects—it seems reasonable to say that the time gained from this elimination or decreased attention to the twenty-five foregoing subjects may wisely be given to the seventeen subjects which demand more attention. While it is true that it is impossible to say how much time will be saved through this change in emphasis, it should be borne in mind that the superintendents overwhelmingly favor increased emphasis on the fundamental divisions of arithmetic—addition, multiplication, subtraction, and division. Surely, with more thorough instruction in these fundamental subjects, a distinct saving of time might be gained. It should be noted that the method of learning most of the twenty-five subjects is through memory, while the method of learning the new subjects is, with the exception of the fundamentals, largely through thinking or rationalization. It is believed that the superintendents may wisely adopt the plan of lessening the emphasis upon the twenty-five subjects and uniformly increasing the emphasis on the seventeen subjects. Surely, this is in the direction of a more *economical use* of time.

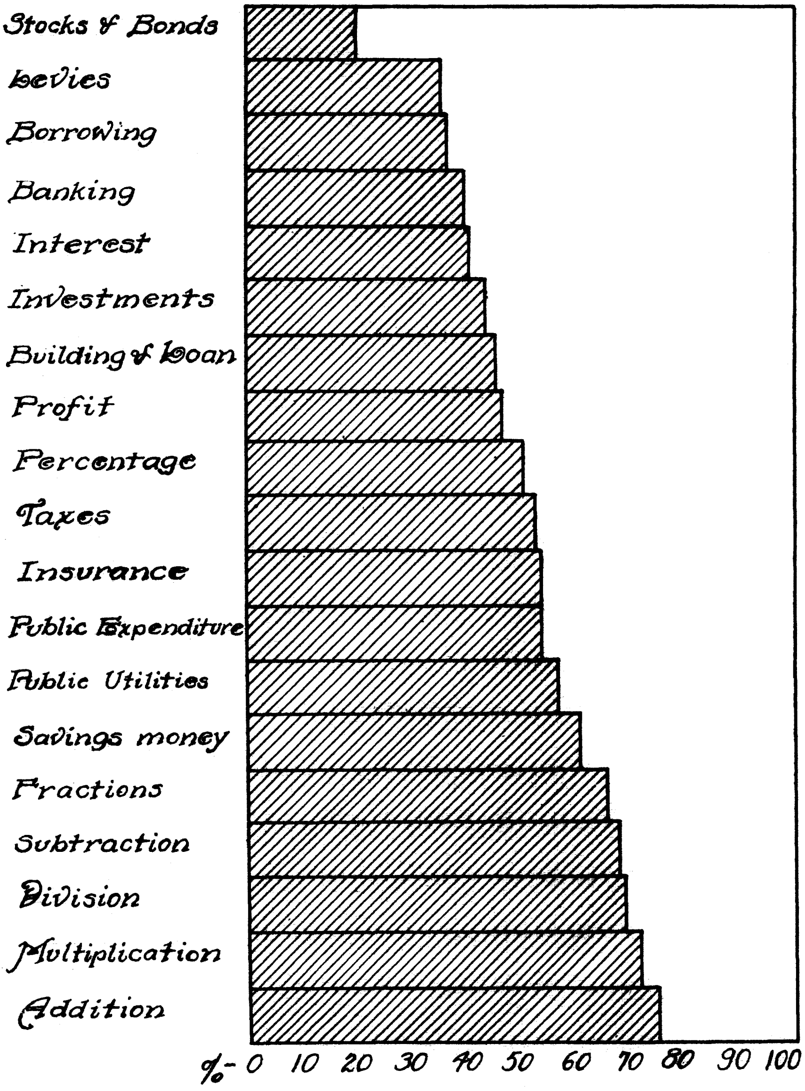

CHART II.—Percentage of superintendents who favor giving more attention to each of these topics (830 cities represented).

AMOUNT OF TIME GIVEN TO THE RECITATION OF ARITHMETIC

Reports were received from 630 superintendents showing the actual time distribution for the recitation in arithmetic in each grade in each city. The wide variation found in time expenditure is shown in Table IV. This table should be read as follows: in the first grade 136 cities allow no time for arithmetic, 7 allow 15 minutes per week, 18 allow 25 minutes per week, and so on down the column. (Extreme cases were verified by supplementary correspondence, so that the variations here indicated are truly descriptive of variations in practice.)

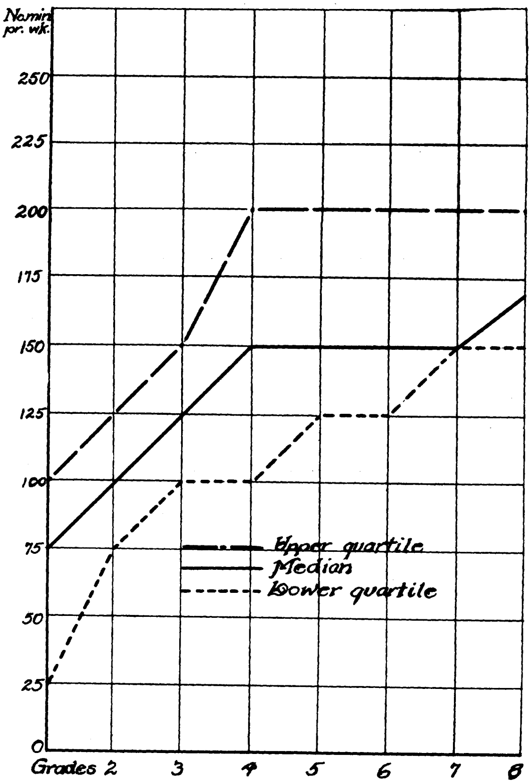

CHART III.—Showing median and quartile distribution of time per week given over to recitations.

Chart III shows graphically the variation and the central tendency in practice. It is seen that the median time spent in

TABLE IV

No. Minutes per Week	Grades								
	1st	2d	3d	4th	5th	6th	7th	8th	9th
0	136	31	4	......	......	......	......	24	439
15	7	2	......	......	......	......	......	......	......
20	......	......	......	......	......	......	......	......	......
25	18	1	1	1	1	......	......	......	......
30	10	7	5	1	......	1	1	1	......
35	1	......	......	......	......	......	......	......	......
40	6	4	2	5	2	1	......	1	2
45	......	......	......	......	......	......	......	......	......
50	99	36	3	1	4	4	2	2	......
55	......	......	......	......	......	......	......	......	......
60	27	22	10	5	3	4	5	5	4
65	1	......	......	......	......	......	......	......	......
70	3	3	1	1	1	1	2	1	1
75	103	127	59	12	4	......	......	2	......
80	6	5	10	11	2	3	1	1	1
85	......	......	......	......	......	......	......	......	......
90	5	6	12	3	4	2	3	3	2
95	......	......	......	......	......	......	......	......	......
100	108	83	156	129	71	31	14	10	3
05	......	......	......	......	......	......	......	......	......
10	1	1	6	5	3	......	......	2	1
15	......	......	......	......	......	......	......	......	......
20	6	10	13	13	12	19	22	18	4
125	17	40	90	113	132	109	59	36	5
30	......	3	4	5	6	9	3	......	2
35	......	......	......	......	......	......	......	......	......
40	......	......	2	4	6	1	9	8	2
45	......	......	......	......	......	......	......	......	......
150	53	66	98	129	158	196	210	192	30
55	......	......	......	......	......	......	......	......	......
60	1	2	4	4	6	2	7	8	5
65	......	......	......	......	......	......	......	......	......
70	......	......	2	3	3	1	......	2	......
175	6	8	9	20	31	28	35	37	6
80	2	5	6	3	5	9	16	15	4
85	......	......	......	......	......	......	......	......	......
90	......	1	......	......	......	1	......	......	......
95	......	......	......	......	......	......	......	......	......
200	11	33	54	56	52	72	96	121	60
05	......	......	......	......	......	......	......	......	......
10	......	3	2	......	1	......	2	5	7
15	......	......	......	......	......	......	......	......	......
20	......	1	1	2	1	1	1	2	2
225	4	10	25	19	22	28	31	38	27

TABLE IV—*Continued*

No. Minutes per Week	Grades								
	1st	2d	3d	4th	5th	6th	7th	8th	9th
30	......	......	......	1	1	2	2	2	......
35	......	......	......	......	......	......	......	......	......
40	......	4	8	8	4	4	4	7	1
45	......	......	......	......	......	......	......	......	......
250	1	9	25	39	51	51	45	34	13
55	......	......	......	......	......	......	......	......	......
60	......	1	......	1	1	2	2	2	......
65	......	......	......	......	......	......	......	......	......
70	......	......	1	1	4	3	2	1	1
275	......	2	2	8	7	9	8	5	1
To 300	......	4	14	24	30	30	38	33	5
To 350	......	......	......	3	2	3	7	8	2
To 450	1	1	1	......	......	......	2	3	......

the first grade for the United States as a whole is 75 minutes; for the second grade, 150 minutes; for the third grade, 125 minutes; for the fourth, fifth, sixth, and seventh grades, 150 minutes; for the eighth grade, 165 minutes. This means that one-half of the cities spend this amount of time or more in the various grades, and one-half this amount of time or less. The 25 percentile shows that one-fourth of the cities spend 25 minutes or less in the first grade; 75 minutes or less in the second grade; 100 minutes or less in the third and fourth grades; 125 minutes or less in the fifth and sixth grades; and 150 minutes or less in the seventh and eighth grades. Again, the upper quartile brings out the fact that another fourth of the cities spend 100 minutes or more in the first grade; 125 minutes or more in the second grade; 150 minutes or more in the third grade; 200 minutes or more in the fourth, fifth, sixth, seventh, and eighth grades. Thus, from the foregoing analysis it may be seen that some spend relatively far more time than others on arithmetic. Comparison of the 157 cities spending the greatest amount of time with the 157 cities spending the least amount of time indicates that already many of these cities are making headway in the economy of time. May we not look to these cities for suggestions? If one-fourth of the cities can get satisfactory results with an expenditure of from 5 to 20 minutes per day or less in the first to fourth grades, there is reason for inquiry as to the accomplishment of cities which spend from 20 to 40 minutes or more per day during the first to fourth grades. Again, if one-fourth of the cities are able to get satisfactory results in from 20 to 30 minutes per day or less in the fifth to eighth grades, certainly we have cause to question the reason why another fourth of the cities spend from 40 to 60 minutes or more per day in these grades. On the whole, it seems safe to say that the wide variation of recitation time in the various cities of the United States suggests the possibility of attempting to effect an economy of time by means of standardizing the number of minutes in the recitation period.

A comparison of the actual results obtained in cities giving a large amount of time to the recitations in arithmetic with the cities giving a small amount of time would be invaluable in arriving at this standard amount of recitation time for each grade. It may be said, however, that practically all of the investigations which have been made thus far on this subject indicate that there is less relation between the time expenditure and the achievement than many have supposed. In other words, from these investigations, we have no reason to expect that city A which gives twice as much time as city B to arithmetic will get results in the same proportion.

It would seem that the conservative superintendent who is spending a relatively large amount of time on arithmetic might safely reduce the time at least to the median for the country for each grade. The less conservative superintendent might reduce the time to the 25 percentile without endangering his school, while the radical superintendent might join the 157 who spend still less time on the arithmetic recitation. Thus, the 50 per cent of the cities spending the most time might simply join the 50 per cent spending the least time. Surely, this plan need not frighten even the most cautious, because half of the cities have already tried out the reduction plan.

It is noteworthy that the North Atlantic and South Atlantic states spend from 25 to 50 per cent more time in arithmetic than do the cities in the other parts of the country. It would be interesting to compare the arithmetical efficiency of the schools in the different sections.

Large cities seem to give more time to arithmetic recitations than do smaller cities, although the difference is not great. The county superintendents reporting on rural schools report a very much smaller proportion of time given to the arithmetic recitation. This is, no doubt, due to the difference in the organization of the daily program in the rural schools.

However, these differences in practice are not so great as to make it impossible for the adoption of the sliding standard suggested above. No section or city differs so much from the central tendency as to make it difficult to work toward some part of the lower half of the curve of time distribution for recitations in each grade.

DISTRIBUTION OF TIME AMONG THE DIFFERENT GRADES

It is interesting to note that the median time distribution for the grades shows a regular increase in the time given to the recitation in the classes up to the fourth grade. Chart III shows this clearly. For example, the median for the first grade is 75 minutes per week; for the second grade, 100 minutes per week; for the third grade, 125 minutes per week, and for the fourth grade, 150 minutes per week; beyond which grade there is no increase.

Certain sectional differences are found. For example, the median time in the North and South Atlantic states increases up to the seventh grade which is the maximum; while the median time in the North Central, South Central, and Western states reaches a maximum in the sixth grade. Analysis of the data indicates that the large city gives more time to arithmetic in the sixth and seventh grades than in the eighth, which is contrary to the practice in smaller cities. Such variation in practice simply emphasizes the possibility of effecting economy of time through the widespread adoption of a standard for the recitation time as suggested above.

PERCENTAGE OF RECITATION TIME GIVEN OVER TO DRILL

The superintendents were asked to make a tabular statement showing the percentage of recitation time in each grade given over to drill. Analysis of these returns revealed a wide variation in practice. Chart IV shows graphically the situation in terms of medians and quartiles for 564 cities.

It should be noted that the median percentage of time given to drill in the city schools begins in the first grade at 43 per cent, increasing to 53 per cent in the third grade, and decreasing steadily from then until the close of the eighth grade, which means that one-half of the cities spend this percentage or more of the recitation time in drill and one-half spend this percentage or less in each grade. The wide variation in practice is revealed by comparing the line which indicates the lower quartile with the line which indicates the upper quartile. That is to say, one-fourth of the cities spend 25 per cent of recitation time or less in drill in the first grade, 35 per cent or less in the third grade, decreasing to 5 per cent or less in the eighth grade; while one-fourth of the cities spend 80 per cent or more of the time in drill in the first grade, and 25 per cent or more in the eighth grade. The same variation exists in the country schools. These answers are significant in that they express the idea which the school superintendents and teachers have in regard to the emphasis which should be placed on drill in each grade. They clearly show that the distribution of time in the recitation between drill work and the so-called rationalizational work is not standardized.

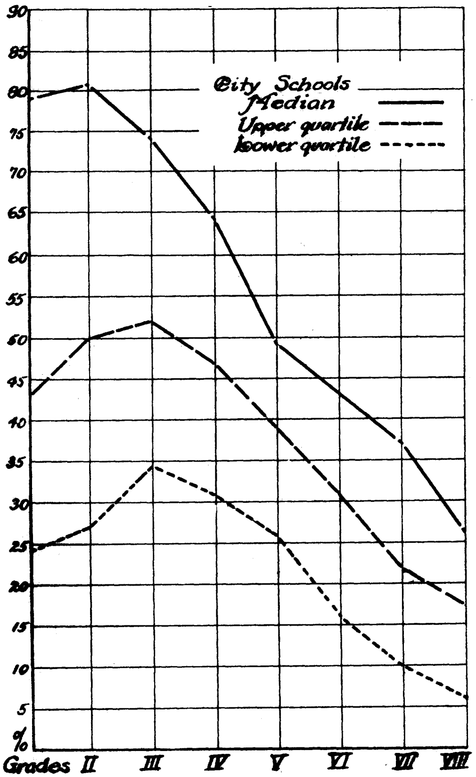

CHART IV.—Showing the median percentage of time given over to *strictly* drill work in the recitations in each grade (564 cities).

We have no adequate means of evaluating the comparative arithmetical efficiency obtained in the schools differing in the amount of time given over to drill. However, it would seem safe to say that if one-fourth of the cities are devoting 80 per cent or more of the recitation time in the third grade to drill, 50 per cent or more in the fifth grade, and 25 per cent or more in the eighth grade, we should inquire into the effectiveness of the arithmetic teaching in the 140 cities devoting 35 per cent or less of the recitation time in the third grade to drill, 26 per cent or less in the fifth grade, and 5 per cent or less in the eighth grade. In other words, such wide variation suggests the *possibility of waste in the method* at this point.

A thoroughgoing comparison of results attained in cities with widely different standards for the time given to drill would be of great value in connection with constructive recommendations. The scientific investigations on the value of drill in arithmetic have thus far been confined to a narrow range of time, grades, and other conditions. However, the results of these investigations have led to the conclusion on the part of the investigators that drill within the limits of their investigation is of decided value.

In the absence of scientific data for the evaluation of the different degrees of emphasis on drill, it is of importance to know the central tendency of existing practice based on the experience in hundreds of cities. A conservative view will no doubt tend toward the *adoption of a standard such as the median for the whole country* unless local conditions offer some specific reason to do otherwise.

Analyses of the replies on the basis of the size of cities represented revealed only slight difference in the time distribution for drill in the cities of different sizes.

Further analysis of the returns reveals the difference in different sections of the country. The North Atlantic section stands out in striking contrast to the South Atlantic section in that in the North a very much higher percentage of time is devoted to drill in the first three grades than in the South. It would be of interest to compare the arithmetical achievement in the schools of the North Atlantic division with the schools of the other sections where very much less emphasis is placed on drill in these grades.

It is significant that there is great agreement in regard to the emphasis placed on drill in the three lower grades. This is true not only for the country as a whole, but it is also true for cities of different sizes and for the different sections of the country. *Experience seems to have become standardized in regard to stage of emphasis if not as to degree of emphasis.*

SUMMARY

This study reveals the fact that there is an overwhelming tendency on the part of half of the superintendents in this country in favor of either eliminating or lessening the attention to be given to certain subjects in arithmetic such as alligation, cube root, unreal fractions, progression, and certain obsolete tables such as folding paper, surveyors' tables, etc. Again, it reveals an overwhelming attitude in favor of increased emphasis on such fundamental subjects as addition, multiplication, subtraction, and division. There is also a decidedly strong disposition to favor increased emphasis on the application of arithmetic to the social and economic conditions of the day, such as the saving and loaning of money, taxation, public expenditures, life insurance, etc.

The wide variation in the recitation time given to arithmetic as a whole, and in the different grades indicates that many cities are already effecting a large economy of time in this particular. *It is recommended that the 50 per cent of the cities spending the most time reduce this to the amount being expended by the 50 per cent of the cities spending the least time.* This plan would cut the range of practice in two, and still give opportunity for the expression of the conservative and radical points of view. This standard is shown in Chart III.

The wide variation in the percentage of time given to drill indicates the importance of scientific investigations of the relative achievements secured from the different time allotments. The median time allotment in practice now in the different grades throughout the United States most nearly represents the judgment of the school men based on their own experience. It is *suggested that this median percentage of recitation time given over to drill in each grade be adopted as a standard until scientific investigations have proven this to be in error.* This standard is shown in Chart IV.

In conclusion it should be said that this investigation clearly points to the desirability of a study of relative achievements attained in the work in arithmetic in these same schools.